Open Source Software: No Free Lunch?

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Is Open Source Software a savior for cash-strapped schools and national governments?

One of the most hotly debated topics in the field of educational technology today surrounds the question of whether it is better for school systems to use open source software (OSS) or commercial software products. There are no simple answers to this question since they involve policy, commercial, technical, and educational concerns. This article will not attempt to provide just one simple answer. Rather, we will highlight the more critical elements that are important to consider when deciding whether or not to use open source software in educational computer systems.

Education Tends to Lag the Commercial Sector

An important factor for educational computer investments is that, with rare exception, education follows the ebb and flows of the commercial sector—often making its investments after commercially developed products have matured and the cost structure has reduced to below commercial levels. Education historically takes advantage of the mistakes and the investments that the commercial sector has made on newer products and then makes adaptations and uses suited to its own purposes. On rare occasions, the education sector commands such a large part of the initial market that it actually spawns computer solutions—but usually not for long.

The Function & Uses Are the Key Basis for Technology Decisions

For education in particular, the functions to be supported and the needs of end users are the most important factors in making technology decisions. If the software and hardware solutions do not ultimately serve the teaching and learning process, then even "inexpensive" investments can be very costly, educationally. If key educational programs cannot be used on computer systems with "free" software, then "free" could actually become very expensive. Similarly, educational uses and needs for computers are different from those of corporations—and decision making about technology choices needs to reflect these differences.

Open Source Software Defined

Open source software is software usually available on the Internet that people can freely use and run without cost or restrictions. Users of open source software can also modify the computer code and redistribute it to others. Linux, part of the family of UNIX-based operating systems is one of the most popular open source software used for operating systems (the master programs guiding computer operation). While other open source software, such as BDS and Berkeley UNIX are well known, Linux, supported by such groups as Caldera Systems, MandrakeSoft, Red Hat, and SuSE, is now at the center of the open source debate in education.

Linux, The Center of the OSS debate

Depending on how one calculates, studies have shown that Linux is the first or second most popular operating system software for Internet servers--accounting for about 30 percent of all web servers. Microsoft Windows NT, a commercial product, accounts for about 50 percent of the market of web server software by IP address and 24 percent of the market by domain names. Studies have also shown that Linux's popularity for Internet servers is growing faster than any other server operating system. Linux is also becoming increasingly common on servers in corporate and university computer networks. In contrast, however, Linux is rarely used as a client operating system (on the end terminal or PC at the user's desk). Only about 4 percent of client or end user computers use Linux compared with over 87 percent of client systems using some version of Microsoft Windows operating system software. The primary reason for this is that there are very few software applications, such as word processing, that can be used on computers running Linux. The exception is WordPerfect's and Sun's StarOffice's application suite (now called OpenOffice since it was released as an OSS application). Recently, technology planners for pre-university school systems have shown increasing interest in the potential of using Linux on their computer systems. Because of the growing importance of Linux and its exemplarity as Open

Source Software, this article will focus its discussion of OSS in education around the question of using Linux.

In Support of Open Source Software

Proponents of open source software (OSS) often emphasize the technical benefits of using this category of software as well as the low or negligible initial costs to acquire the software. In addition, people who use OSS highlight the fact that using OSS is free from the constraints of complex licenses that control how commercial software can be used.

The technical benefits of OSS are generally discussed in terms of the software's reliability, performance, scalability, security and its open code. The best way to evaluate the cost issue surrounding OSS is to look at the total cost of ownership (TCO). TCO assessment seeks to evaluate the range of lifetime costs involved in acquiring, installing, configuring, supporting, maintaining, training users, using, and upgrading the software. Using Linux as an example of operating system software used on servers, each of these technical considerations and the TCO question will be briefly described below.[1]

- **Reliability**: A variety of comparison tests between Linux and other server software applications have shown that servers running Linux crash less often than servers running Microsoft NT as well as other commercial and OSS operating systems software. The higher reliability ratings for Linux are often explained by the fact that developers working in different server environments can modify Linux's source code to optimize the software for specific hardware platforms and diverse systems, thus improving Linux's overall reliability. Taking advantage of this feature of OSS obviously requires a high degree of sophisticated technical expertise, a level of skill that is not often present in poorer and smaller schools and school systems.

- **Performance**: In comparison tests, Linux has also been shown to be the best performing server operating system in comparison to Microsoft NT and other commercial and OSS applications. Again, this higher level of performance is explained by Linux's open software code that enables people with the needed skills to optimize the software for a specific platform and configuration. It is important to note that the results from performance tests are very sensitive to the overall conditions surrounding such tests and specific computer configurations.

- **Scalability**: Because Linux's code can be optimized for different size platforms, it is said to be more scalable than Microsoft NT. Also, Linux can be used on a wider range of computer platforms than any other operating system. The combination of these two factors makes Linux a far more scalable operating system than many alternatives. Institutions can use Linux on a small computer system and expand the system while continuing to use Linux with no loss of performance or reliability. (At the corporate level, Linux suffers some on scalability measures compared to other Unix products.)

- **Security:** Even though it is difficult to quantitatively determine if one software package is more secure than another, there is a general consensus that Linux is more secure than Microsoft NT, primarily because of the large number of developers around the world working to identify and correct security problems. One measure of the security of Internet server software involves the number of web sites that are broken into by hackers and defaced. Studies of defaced web sites show that "most defaced web sites are hosted by Windows, and Windows sites are disproportionately defaced more often than explained by its market share." (David A. Wheeler, 12/3/01)

- **Total Cost of Ownership (TCO)**: Determining the total life-time cost involved in purchasing, supporting, configuring, training users, upgrading and using software is difficult. Underlying assumptions, the local technical and market environment in which software is used and the availability and cost of computer technicians with the necessary skills easily influences TCO calculations.

As shown in the **tables** below, Linux and other open source software usually have significantly lower initial costs than commercial operating system software such as Microsoft Windows 2000. (Wheeler, 12/3/01)

	Microsoft Windows 2000 (Sample U.S. Retail Prices)	Red Hat Linux
Operating System	$1510 (25 client)	$29 (standard), $76 deluxe, $156 professional (all unlimited)
Email Server	$1300 (10 client)	included (unlimited)
RDBMS Server	$2100 (10 CALs)	included (unlimited)
C++ Development	$500	included

	Microsoft Solution	OSS/FS (GNU/Linux) Solution	Initial Savings by using GNU/Linux
Company A (50 users)	$69,987	$80	$69,907
Company B (100 users)	$136,734	$80	$136,654
Company C (250 users)	$282,974	$80	$282,894

Many businesses have saved thousands or millions of dollars by switching from commercial server software to Linux and other open source applications. Much of these savings are possible because these companies have the technical staff needed to install, configure, locate or develop drivers required to use peripherals, track and install revisions and patches (small packets of code developed to solve problems and enhance the software), develop and modify applications, and provide on-going technical support. In most cases, it appears that a vast majority of businesses that switch to Linux and other OSS only deploy this software on servers and not on end user client systems.

There are three main reasons for this limitation in how Linux is deployed in institutions:

- As mentioned above, there are few client software applications available that can be used on Linux or other OSS operating systems without using special software emulators;
- Few end users are familiar with using Linux and providing the needed training to large numbers of end users often is very expensive; and,
- The lack of end user skills translates into significantly higher costs to support and maintain Linux on large numbers of distributed client computers than is need to support Microsoft Windows or Apple's Mac operating system software.

Software Standards and OSS -- One Person's Benefit is Another's Loss!

One of the important benefits of OSS, especially for programs as popular as Linux, is that software programmers around the world are free to modify the source code (the core instructions for operation) and develop new features. This results in a high level of creativity and, as mentioned above, is partly responsible for making Linux more stable, scaleable and secure than competing programs. The open source development environment that is responsible for the many benefits of OSS is also responsible for one of the major challenges facing OSS; the lack of centrally controlled standards that stop the release of poor software code and prevent different modifications from causing software conflicts. To address these problems, the OSS movement has developed an "honor code" and volunteer groups that police and certify modifications and additions to major OSS applications such as Linux. However, as the popularity of Linux grows and the number of programmers in countries around the world who work on Linux increases, the potential for serious problems caused by the lack of centrally controlled standards will likely increase. This may eventually result in the evolution of Linux into versions that are incompatible with each other. Decisions to use Linux must carefully consider problems and costs that may result from having to maintain and support OSS in a dynamic and changing environment.

When is Free Software the More Expensive Choice?

Proponents of using OSS in educational computer environments often emphasize the fact that OSS is "free" and that the savings of money from not having to purchase operating system software is a sufficient reason to use Linux. Unfortunately, this argument is seriously flawed. Operating system software only accounts for about 5 to 8 percent of the total cost of buying a client computer system. In contrast, the on-going costs to train teachers to integrate technology into teaching and learning and to support and keep computer systems running from year to year can be many times greater than the original purchase cost of the computer. In many cases, school systems will spend in two years as much for operations as was spent initially to purchase and install a system that is expected to last for five years. As mentioned above, it is therefore more important to carefully consider the TCO of educational computer systems when evaluating the real costs of using different types of operating system software. An important feature of TCO studies is that they need to be customized to the unique conditions and circumstances of the school system and country where the computer systems will be used. The results of a TCO study carried out in one country will most likely be significantly different from a study carried out in another country. Even within countries, TCO studies can be significantly different. It is also important to emphasize that TCO studies carried out for corporations cannot and should not be used to justify purchase decisions for educational systems. There are special and critical differences between the needs and uses of computers in education and corporations.

Governments and schools decide to invest in computer systems for schools because they believe that using computers

and the Internet in schools will result in important educational benefits for their students and teachers. At a minimum, these benefits include ensuring that students gain the computer literacy skills they will need to find employment and perform well in post-secondary education. More importantly, educators seek to improve the quality of teaching and learning in schools by integrating the use of technology. Buying and installing computer systems in schools is a necessary condition for realizing these potential benefits. However, simply putting computers in schools is not a sufficient condition to ensure that education will be improved. The most important factor in realizing the potential educational benefits of technology is how teachers and students use computers and the Internet in learning activities. Consequently, the most important COST factors in TCO studies of technology in education are linked to the use and application of technology to teaching and learning. Therefore, when evaluating the use of OSS in education it is essential to assess how different software decisions will effect how teachers and students use technology.

Human Capacity Development Considerations: The largest and most important investment in educational computer systems is building and strengthening the capacity of teachers to integrate the use of technology in to their teaching routines. Building this capacity requires a long-term investment in training and on-going pedagogical support. In Brazil's ProInfo program,[2] for example, ***over 40 percent of the program's budget was dedicated to initial teacher professional development and training.*** In addition to the initial investments in building teachers' computer literacy skills and an understanding of sound pedagogical uses of technology, ProInfo staff at the federal, state and local levels have made significant and continual investments in building teachers' confidence to use computers and the Internet in their teaching. Program staff, teachers and schools involved in ProInfo have also invested significant time and resources in developing successful project-based learning strategies that make effective use of computers and the Internet and which are starting to have important impacts on the quality of student learning. ***The financial value of these investments in the educational capacity of the trainers, teachers, students and schools involved in ProInfo are several hundred times greater than the initial cost of the computers and several thousand times greater than the cost of the operating system software used on these computers.***

The momentum of the ProInfo program is now accelerating the process of enabling more and more teachers across Brazil to learn to use computers and the Internet and to integrate the use of these tools into their teaching. It has taken over five years to reach the point where there is a critical mass of teachers and schools actively using technology in teaching and learning that is now driving the process forward at an exponential rate of growth.

If the government of Brazil were to develop a TCO model to evaluate the costs of switching from a Microsoft Windows operating system for client, end-user computers that are currently used in schools to Linux, they would have to include the costs of rebuilding the skills and confidence to use computers in thousands of teachers across the country. Similarly, it would be necessary to account for the costs of not having students use computers in schools for several years that would result as teachers without needed skills and confidence would stop making effective use of computers in their teaching. It is likely that the costs associated with these human capacity development losses among trainers, teachers and students would be several thousand times larger then the savings realized by using Linux rather than Windows on client systems.

Technical Support Considerations: Even though the human capacity development cost factors discussed above are the most important elements of a TCO calculation for education systems, they are not the only ones that need careful consideration. One of the lessons from Brazil's ProInfo program is that technical support to keep school computer systems running and to help teachers implement their learning projects with technology is essential. Without this support, small technical problems can prevent effective use. More importantly, the lack of support can cause teachers to not use computers for fear that they experience embarrassing problems that they cannot solve. A shift from Windows to Linux would require states, municipalities and schools to spend thousands of dollars and years rebuilding the technical support capacity essential to making effective use of computers in education.

Matching Skills to Needs: Windows is the operating system used on 80 to 90 percent of all client computers in business, government and the non-profit sectors of the economy. If students were to use computers in schools with Linux, some would likely not gain needed skills and experience with Windows that perspective employers would demand. Therefore, TCO calculations for education systems considering Linux would need to consider the costs that students and companies would likely incur to train workers to use Windows.

Educational Software Applications: The lack of educational software applications that can operate on Linux and the loss of current investments in Windows applications that could not be used on Linux would also need to be considered in TCO calculations. Furthermore, many schools, especially those in developing countries, have very small budgets to purchase additional software for their computer systems. A shift to Linux would make some current investments useless and replacing the software with versions to run on Linux, if available, would drain scarce resources. Also, some critical applications, such as software used in special needs educa-

tion, is not presently available for the Linux operating system and a shift to Linux could prevent some students and schools from making any use of their computers.

Optimizing Investments in Educational Computer Systems

Even though it may be far too costly for educational systems to consider using Linux or other OSS programs on client or end user systems, education planners can likely discover how to benefit most from using OSS by mirroring how the corporations and businesses have capitalized on the benefits of OSS. As described above, the dominant use of Linux in corporations is on Internet servers followed by running Linux on office network servers. Since servers are usually set up and maintained by skilled technicians, it becomes less of a problem to train them to install and maintain a new operating system. However, care should be given to evaluate which level of school networks should use new server software that is not well known by technicians. Schools in smaller communities with a few technicians skilled in the use of Unix or Linux may incur greater support and training costs than they would save from using the OSS options. This situation will differ from place to place. For example, in Namibia there are more computer technicians and companies with Unix/Linux skills than those with Microsoft Windows NT skills. Therefore, it may make economic sense for schools to use Linux for their servers than to use Microsoft products. In Brazil, however, the opposite is true. Technicians skilled in Unix/Linux operating systems on servers are only present in relatively low numbers in the largest cities and universities.

If investments are being made to build completely new educational computer systems in schools with no legacy systems, then the TCO model will likely favor OSS when used strategically. With completely new educational computer systems, the issue of losing past investments in training and software will likely not exist and it can become economically beneficial, in the short and long term, to consider implementing Linux or other OSS at the level of Internet and school network servers.

Concluding Considerations for Educational Computer Programs

When considering the technical specifications of educational computer systems, especially regarding the use of OSS, it is critical that the primary goals and objectives of such systems – significantly improving the quality and equity of teaching and learning – must remain the principal focus of decision making. If decisions to use OSS are made for short-term or immediate cost savings, it is possible that the long term costs, both financially and educationally, may become excessive. As described above, the development of TCO models to assist decision making must be developed to reflect unique local realities and include the significant *hidden costs* associated with building the capacity of educators to effectively integrate the use of computers and the Internet into routine teaching and learning.

At the same time, the definite benefits and advantages from the strategic use of OSS should be used in educational systems. Because there is little quantitative information about the use of OSS in educational computing systems, it could be very useful if universities, government agencies, NGOs and the private companies would plan and carryout pilot projects, in collaboration with schools, to evaluate the use of OSS, especially Linux, in school computing environments. Such pilot projects could evaluate the impact and potential cost savings of using Linux in specific school, local and national environments. The results from pilot projects could then be used to both assist education planners in making decisions about how to use OSS in schools and to encourage the development of OSS applications targeted at the needs of education.

Clearly, the OSS movement will continue to grow and provide new options for educators—in part as an outgrowth of the benefits accruing to the commercial sector from OSS. Educators will need to follow and participate in these developments to ensure that strategic benefits for teachers and students can be realized. Just as with the first introduction of the PC to supplant the mainframe computer, in the near future the answer to the question, "Is Open Source Software a savior for cash-strapped schools and national governments?" becomes more obvious.

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[1] Much of the information about the technical aspects of Linux was extracted from David A. Wheeler's excellent article, "Why Open Source Software / Free Software (OSS/FS)? Look at the Numbers!" (12/3/01). http://www.dwheeler.com/oss_fs_why.html

[2] ProInfo is a national program in Brazil, started in 1997, that works in partnership with state and local authorities to establish a network of teacher training and technology resource centers across the country, build computer labs in public primary and secondary schools in all states, and train thousands of trainers and teachers to integrate technology into all aspects of the curriculum.